University Of Cincinnati

Qualified Electrical Worker Safety Program

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1.0 PURPOSE

This program establishes the minimum requirements for employees and contractors that work on or near electrical equipment at all University of Cincinnati locations. This standard implements the requirements of NFPA 70E-2015 edition (Standard for Electrical Safety in the Workplace) which is enforced by OSHA standards 29 CFR 1910.331 – 1910.335. This document also addresses OSHA standard 29 CFR 1910.269 (Standards for Electric Power Generation, Transmission and Distribution).

2.0 SCOPE

This program shall be considered mandatory and applies to all electrical work that may entail risk of electrical shock and/or, the risk of thermal burn from electrical arc flash (i.e. whenever working on or near exposed energized electrical conductors operating at 50 volts or greater AC or DC.).

Specifically, this program applies to all University employees or contractors at any University location or at work locations governed by the University of Cincinnati.

3.0 AUTHORITY

This is a University of Cincinnati safety program that establishes the minimum requirements for all sites where employees, contractors, and vendors are stationed. To the extent this program conflicts with federal or local legal requirements, the more stringent requirements shall be followed as long as they do not violated any legal requirements.

OWNERSHIP OF THIS POLICY: Environmental Health and Safety Department (EH&S) shall be responsible for keeping this document in its entirety and all subsequent related documents current to include any referenced material that may be updated or revised. These changes shall be listed in an addendum in the back of this document.

4.0 Definitions

Accompanying person: A qualified person who accompanies unqualified employees or visitors in areas surrounding High and Low Voltage electric lines or equipment.

Addendum: an item of additional material, typically omissions, added at the end of a book or other publication.

Authorized Employee: An employee who locks or tags machines or equipment in order to perform servicing or maintenance. This would be a person trained in LOTO.

Barricade: A physical obstruction such as a tape, rope, cones, a wooden or metal structure, whose aim is to notify the hazard or limit the access to a hazardous area.

Blocking: The placement of a blocking element in energy isolating device in agreement with an established procedure, (LOTO) is making sure that the energy isolating device and the equipment that is being controlled cannot be used until the blocking element is removed.

Blocking device: A device that uses a positive means such as a lock with key or padlock to maintain an energy isolating device in a safe position to prevent the energizing of a machine or equipment.

Busbar: A conductor or group of conductors that are used as a common connection for two or more circuits.

Circuit: A conductor or system of conductors through which electric current is foreseen to flow.

Contractor: A person or company that undertakes a contract to provide materials or labor to perform a service or do a job.

Conductor: A material, normally in the form of a wire, cable or bar, which is suitable to conduct electric current.

Covered conductor a conductor encased within material of composition or thickness that is not recognized by the NEC as electrical insulation.

De-energized – Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of earth. (De-energized does not describe an electrically safe work condition, e.g., a circuit that has been disconnected but not controlled and verified.)

Dielectric check: A controlled method, used to check the insulation or dielectric strength, in order to know the integrity of the electric equipment, for personal protection and live work safety. (I.e. megger or Hi Pot)

Electrical installation: The group of materials and equipment of a workplace by means of which electricity is generated, converted, transformed, transported, distributed or used. They include batteries, capacitors and any other equipment that stores electricity. The definition of "electrical installation" adapts to the environment that concerns us, the working environment, and specific equipment are mentioned in recognition of the risks they entail, such as batteries, capacitors and any other equipment that stores electricity.

Electric risk: Risk caused by electricity. The risks given below are specifically included:

- Electric shock due to contact with live elements (direct electric contact), or with masses accidentally made live (indirect electric contact).
- Burns due to electric shock or electric arc.
- Falls or blows as a result of electric shock or arc.
- Fires or explosions caused by electricity.

Not only the probability of suffering an electrical discharge (either due to direct or indirect contact) that produces the initial physiological effect due to the passage of current through the human body is understood, but other types of associated risks/effects have also been considered, which are generally considered separately and are relatively frequent, such as burns, falls, fires, explosions, intoxications, etc., whose origin is the improper or accidental use of electricity.

Electrically Safe Work Condition: A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.

Energy isolating device: A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following: A manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors and, in addition, no pole can be operated independently; a line

valve; a block; and any similar device used to block or isolate energy. Push buttons, selector switches and other control circuit type devices are not energy isolating devices.

Energized: Machines and equipment are energized when they are connected to an energy source or they contain residual or stored energy. (Electrically connected to, or is, a source of voltage. NFPA 70-E)

Energized Work: Performance of electrical work on which an Energized Electrical Work Permit may be required.

Energized Electrical Work Permit: When working on energized electrical conductors or circuit parts that are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility per 130.2), work to be performed shall be considered energized electrical work and shall be performed by written permit only. **See Appendix "E"**

Exposed: *(As applied to live parts.)* Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated

Flash hazard analysis: A study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and appropriate levels of PPE.

Flash protection boundary: An approach limit at a distance from a prospective arc source within which a person could a second degree burn if an arc flash were to occur.

General blocking system: Removed

Grounding/Grounded: Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons

High Voltage: For this internal instruction of U of C, High Voltage installations are understood as those whose rated voltage is over 1,000 Volts in alternating current or 1,500 volts in direct current between phases.

Insulated conductor: A conductor encased within material of composition and thickness that is recognized by the NEC as electrical insulation.

Isolated: Not readily accessible to persons unless special means for access are used. Separated physically, electrically and mechanically from all electricity sources, including possible energy storage

devices and other low voltage sources. All separation devices blocked in open position or that are secured in some other way that will prevent an unnoticed re-establishment. Such separations may not eliminate the effects of electric induction. Being isolated does not mean that it is earthed or that it is safe to work with.

Limited approach boundary (LAB): An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. Only a Qualified Person may cross the Limited Approach Boundary

Line isolating switch/circuit-breaker: A device designed to simultaneously connect or disconnect machines, equipment and / or other High Voltage energy source installations.

Live work: Work during which a worker enters into contact with live elements, or enters the hazard area, either with a part of his or her body or with tools, equipment, devices or materials he or she is handling. The operations and measurements, tests and verifications defined below are not considered as live work.

LOTO: Lock out and tag out as used in this program and procedures. **See appendix "L"** .

Low Voltage: For this internal instruction of U of C, Low Voltage installations are understood as those whose rated voltage is less than 600 Volts for alternating current or 1,500 volts for direct current.

Mobile equipment: This includes, but is not limited to cranes, Lorries (Truck), work platforms and other similar types of equipment.

Measurements, tests and verifications: Activities designed to verify compliance with the specifications or technical and safety conditions necessary for an electrical installation to operate correctly, including those aimed at verifying its electrical, mechanical or thermal status, protection efficiency, safety circuits or operation circuits, etc.

Operation: Intervention conceived to change the electrical status of an electrical installation that does not involve mounting or dismounting any elements. Two types of operations can be distinguished:

•Operations aimed at modifying the electrical status of an electrical installation, in order to use equipment, close or open a circuit, start or stop equipment designed to be used in this way without risks, so long as they are reasonably executable.

•Connection or disconnection operations on installations to carry out work on them. In the particular case of operations executed via connection appliances, the capacities and limitations of the different classes must be taken into account: Isolating switches, circuit-breakers, automatic switches, etc.

Operating system blockage: A lock with key or padlock placed on the High or Low Voltage distribution system to prevent the unintentional activation of an isolating switch or circuit-breaker. The lock operating systems with key or padlock may be unique or common locking systems.

Potentially activated: A non-isolated device or conductor, which, by nature, design or position, may be activated by an activated adjacent conductor, the closure of a switch or return of voltage.

PPE: Clothing and equipment that is designed and constructed to protect workers from electrical shock or to reduce the burns that would be sustained from an electrical arc flash.

Preventive resource: Personnel with sufficient capacity and with the necessary means to watch over compliance with the preventive activities when the risks may worsen or change during the execution of the process or activity, due to the combination of different operations that make it necessary to control the correct application of the work methods. These people will remain at the work center during the time when the situation that determines their presence is maintained. This person is a mandated position in Spain; special classes are given on specifically risk assessment, work stoppage, etc. In the USA we must consider the supervisor/foreman this person to keep line management accountability.

Proximity: Sufficiently near to touch, fall or have accidental contact in any other way.

Qualified worker (As defined by NFPA70E-2015) “One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved”.

Under OSHA 29 CFR1910.269 the definition is “Those who are Knowledgeable in the construction and operation of electric power generation, transmission, and distribution equipment involved, along with the associated hazards”. A qualified person has received safety training to recognize and avoid the hazards involved while working on, or near, exposed energized conductors.

Restricted approach boundary (RAB): An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electrical shock due to electrical arc over combined within inadvertent movement for personnel working in close proximity to the live part.

Rubber protection equipment: Insulating material that includes elastomers and elastomer compounds, without bearing in mind the origin.

Safety lock: This is a controlled lock with key or padlock whose aim is only for personal protection.

Tagging: The placement of an identification device on an energy isolating device in agreement with an established procedure, to indicate that the energy isolating device and the equipment that is being controlled cannot be put into operation until the identification device has been removed.

Tag-out device: The placement of a tagout device on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Temporary: During a period of: construction, remodel, alteration, demolition, repair or testing of electrical components and systems

Tools for live work: Tools for live work can be made of epoxy-glass that is specified for the voltage involved and that is used to touch or go near energized conductors or parts of electrical equipment.

Any hand tool inside the Limited Approach Boundary shall be a 1000 volt certified insulated tool.

Troubleshooting and testing: Actions necessary to measure voltage and current and to verify the operability of equipment without repairing or replacing components.

Unqualified person: A person who is not a Qualified Person.

Voltage-free work: Work on electrical installations that are carried out after having taken all the necessary measures to maintain the installation voltage-free.

Work Manager: Person appointed by the employer to assume the effective responsibility of the work. This is a generic definition that does not, apparently, define the qualification or competence that the work manager must have to direct or supervise the execution of work with electric risk.

5.0 Training Requirements

Each organizational unit is required to ensure that all employees who interact with, work on or near electrical equipment, operating at 50 volts or greater AC or DC, or face a risk of electrical hazards that are not reduced to a safe level by electrical installation requirements receive the necessary electrical safety training. Employees shall be trained in the safety related work practices and procedures that pertain to their ***respective job assignments and tasks***; and identifying and understanding the relationship between electrical hazards and possible injury.
Training shall be classroom, on-the-job training (OJT), task specific, or a combination.

Each organizational unit shall follow EH&S's recommended training requirements per the job classification matrix. i.e. what level of qualified employee training is necessary, according to the degree of risk to the employee.

Training Documentation: Records of experience and training (classroom and OJT) received by each qualified person must be maintained for all personnel covered by this program. Documentation is necessary to demonstrate that individuals have met the training requirements for the types of work performed. Documentation shall be recorded when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of the employees employment. Documentation shall include the employees' name, dates of training, and description of training. Training document for employees shall be maintained and stored under the ownership of the EH&S department and shall be kept current and up to date for the duration of the employees employment.

Contractor Training Documentation: For a contractor to qualify for University contacts it must provide records of experience and training (classroom and OJT) received by each qualified person must be maintained for all personnel covered by this program. Documentation is necessary to demonstrate that individuals have met the training requirements for the types of work performed. Documentation shall be such as outlined in the most current edition of NFPA 70E Electrical Safety-Related Work Practices training documentation requirements.

Qualified Person: A qualified person shall be trained and knowledgeable of the construction and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

(a) Such persons shall also be familiar with the proper use of the special precautionary techniques, personal protective equipment, including arc-flash, insulating and shielding materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still are unqualified for others.

(b) Such persons permitted to work within the Limited Approach Boundary of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

(1) The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment

(2) The skills and techniques necessary to determine the nominal voltage of exposed energized conductors and circuit parts

(3) The approach distances specified in Table 130.4 (C) (a) and the corresponding voltages to which the qualified person will be exposed

(4) The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely

EMPLOYER RESPONSIBILITY: The employer shall determine, through regular supervision and through inspections conducted on at least an annual basis that each employee is trained and complying with the safety-related work practices required by this standard.

Training of Qualified Persons: Employees shall be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indication provided by the device. The training shall include information that enables the employee to understand all the limitations of each specific voltage detector that may be used.

On-The-Job (OJT) Training: An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person and who, in the course of such training, has demonstrated an ability to perform specific duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those specific duties.

Retraining shall be required if:

- Tasks that are performed less often than once per year shall require retraining.
- If the supervisor or other inspection methods indicated that the employee is not complying with safe electrical work practices.
- If new technology, new types of equipment, or changes in procedures necessitate the use of safety related work practices that are different from those that the employee would normally use.
- If the employee must use safety-related work practices that are not normally during his/her regular job duties.

6.0 Safe Work practices

Voltage-free work

Essential indications are given below to carry out voltage-free work, which must be followed to guarantee that the electrical installation within the work area is voltage-free and that it will remain that way during the execution of the work

- Disconnect: The installation where the work is going to be carried out must be disconnected from all power supply sources. Those elements of the electrical installation that are still live after disconnection must be discharged with appropriate devices.
- Prevent any possible feedback: All the operation devices that have been used to disconnect the electrical installation must be secured with mechanical interlocking or blocking system, pins, or other elements, such as warning signals, to avoid any possible reconnection. If blocking is defined, it shall be blocked per proper procedure and (LOTO) will be followed.
- Verify that the installation is voltage free: The absence of voltage must be verified by a qualified person in all active conductors of the electrical installation within, or as near as possible, to the work area, immediately before grounding and short-circuiting. In the case of cable-connected installations, when these cannot be accurately identified in the work area, other means must be adopted to guarantee safety; for example, the use of appropriate cable-cutter or cable-crusher devices.
- Grounding and short-circuiting for 1000 volts and greater: All those parts of the installation where work has to be carried out must be grounded and short-circuited. Grounding and short-circuiting equipment or devices must be connected firstly to the ground tap and then to the grounding elements.

Working On or Near Electrical Conductors or Circuit Parts

Live parts to which an employee may be exposed shall be put into an electrically safe work condition (de-energized) before the employee works within the Limited Approach Boundary of those conductors or parts. Energized work is permitted by a qualified person(s) where the Director or his/her authorized designee of: UTILITIES, ELECTRICAL MAINTINANCE, MAINTINANCE and OPERATIONS, FACILITES MANAGEMENT, PROJECT SERVICES, PARKING, PLANNING DESIGN and CONSTRUCTION OR ENVIORNMENTAL HEALTH AND SAFETY can demonstrate that de-energizing introduces additional or increased hazards. Examples of increased hazards include:

• Interruption of life support equipment,
• Deactivation of emergency alarm systems,
• Shutdown of hazardous location ventilation equipment

Energized (or live) work shall be permitted where a project requestor has completed and signed an energized electrical work permit (appendix “E”) and the Director, or his/her authorized designee, of: UTILITIES, ELECTRICAL MAINTINANCE, MAINTINANCE and OPERATIONS, FACILITES MANAGEMENT, PROJECT SERVICES, PARKING, PLANNING DESIGN and CONSTRUCTION OR ENVIORNMENTAL HEALTH AND SAFETY can demonstrate that the task is infeasible in a de-energized state due to equipment design or operational limitations.

Only qualified persons are permitted to work on energized circuit parts when:

- A greater hazard is created by de-energizing
- Life safety is compromised
- There is a continuous industrial process
- Testing or troubleshooting of electrical equipment

Only qualified person(s) with a job classification of Electrician 1 or higher may work on energized electrical equipment operating above 480 volts.

Prior to working on or near exposed electrical conductors and circuit parts, lockout/tagout
Procedures shall be applied in accordance to UNIVERSITY of CINCINNATI lockout/tagout procedures.

If exposed (live) electrical conductors and equipment cannot be de-energized, other safety related work practices shall be used to protect employees. Safe work practices shall protect employees from arc flash and contact with live parts directly with any part of the body or indirectly through some other conductive object.

These practices shall be determined before any person approaches the Limited Approach
Boundary by using both shock hazard analysis and flash hazard analysis when implemented.

An Energized Electrical Work Permit (See Appendix “E”) must be obtained if live parts are not placed in an electrically safe work condition unless troubleshooting or testing is being performed. This permit shall be kept for a period of one year after completion of work.

Energized or Live work

Before carrying out any live work, a preliminary analysis of the installation must be performed in order to:

- Have a knowledge of the installation electrical circuit, to know the voltages and intensities
- Have knowledge of the proximity operations that have to be carried out.

Any fire and explosion risks must be eliminated, too, before carrying out live work, in agreement with the specifications given in the document on risk assessment of explosive atmospheres of the work area.

Workers using electrical equipment and/or installations:

The level of training and information must be basic, simple and as brief as possible. It must be expressed in easily assimilated terms, and ultimately it will depend on the experience and training of the workers involved.

It is advisable to insist upon the risks that are more likely to occur by virtue of the activity executed by the worker. This training can be completed with precise indications about the specific practices that must be avoided or applied, such as, for example:

- «Do not work with equipment or installations that have faulty cables or plugs»
- «Do not unplug cord connected equipment by pulling on the cord, grasp the plug cap, »
- «Do not handle the interior of the equipment or dismantle it»
- «Do not overload the plugs, making an excessive use of adaptors or terminal strips»
- «In locations with special characteristics (damp, wet, dusty, with fire or explosion risk, construction works, etc.) do not forget to apply the safety measures inherent to that location», etc.

Proximity Work

Establishing Shock and Arc Flash Boundaries

Approach Boundaries to Live Parts. Prior to working on or near live parts, qualified persons shall conduct an analysis to determine the voltage to which personnel will be exposed, the shock protection (i.e. limited, restricted) boundaries, flash protection boundary, and the PPE necessary to minimize the possibility of electric shock and arc flash. See NFPA 70E Informative Annex "C" for information on these boundaries.

Shock Protection Boundary. Shock protection boundaries shall be used when approaching personnel are exposed to live parts. The distances are associated with various voltages and approach boundaries of qualified personnel only. Unqualified persons are not permitted to enter spaces that are not enclosed or otherwise protected if the equipment is not in an electrically safe work condition.

When an unqualified person is working at or close to the Limited Approach Boundary, the qualified person in charge of the work space where electrical hazard exists shall advise the unqualified person of the electrical hazard and warn him or her to stay outside of the Limited Approach Boundary.

In the event there is a need for an unqualified person to enter the Limited Approach Boundary, a Qualified person shall advise them of the possible hazards, and continuously escort the unqualified person while inside the Limited Approach Boundary Under no circumstances shall the escorted unqualified person be permitted to cross the Restricted Approach Boundary.

Arc Flash Hazard Analysis: To protect employees from arc flash injuries, each site must conduct an arc flash analysis to determine the Flash Protection Boundary and required PPE within the Flash Protection Boundary and the personal protective equipment that people within the Arc Flash Protection Boundary shall use.

The arc flash hazard analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically, not to exceed five years, to account for changes in the electrical distribution system that could affect the results of the arc flash hazard analysis.

Arc Flash Protection Boundary: When an arc flash hazard exist, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flashes were to occur.

Protective Clothing and other Personal Protective Equipment: Where it has been determined that work will be performed within the Arc Flash Protection Boundary, one of the following methods shall be used for the selection of protective clothing and other personal protective equipment.

Incident Energy Analysis:

- The incident energy analysis shall determine the incident energy exposure of the worker (in calories/square cm, cal/cm2).
- Each site shall calculate and document the incident energy exposure. Arc-rated (AR} clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task (i.e. in choosing protective clothing, each site must compare the degree of incident energy (cal/cm2) derived from the incident energy analysis, with the ratings of the protective clothing).
- The incident energy analysis must be performed by a professional engineer.
- Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined.
  • In lieu of an incident energy analysis, the PPE requirements outlined in 2015 NFPA 70-E Table 130.7(C)(15)(A)(a) and (b) shall be permitted **until completion of the Arc Flash analysis.**

TEST INSTRUMENTS AND EQUIPMENT USE

Only qualified persons shall perform testing work on energized parts.

Qualified employees must be trained to understand that they are exposed to shock and flash hazards when performing work tasks involving testing.

Each site shall prohibit employee use of a voltage testing device unless the qualified person is trained to use it.

Qualified persons shall be trained to test for the absence of voltage.

Each qualified person must be trained to select an appropriate test instrument and shall demonstrate how to use the device to verify the absence of voltage including interpreting indications provided by the device. This shall be a documented procedure. **See Appendix "M"**

When test instruments are used for the testing for the absence of voltage on conductors or circuit parts operating at 50 volts or more, the operation of the test instrument shall be verified before and after an absence of voltage test is performed. Test instruments shall have a minimum of a category 4 rating.

When test instruments are used for testing and troubleshooting on circuits operating at 50 volts or more, the test instrument shall have a minimum of a category 4 rating.

PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

Each site with employees working in areas where electrical hazards are present shall provide PPE that is designed and constructed for the specific part of the body to be protected and for the work to be performed.

When an employee is working within the Flash Protection Boundary, protective clothing and other PPE shall be worn in accordance with the calculated incident energy and the assigned hazard/risk category.

Protective Clothing Characteristics: NFPA 70E Informative Annex “H” lists examples of protective clothing characteristics and the degree of protection for various clothing. The protective clothing selected for the corresponding hazard/risk category number shall have an arc rating (incident energy rating) of at least the value listed on the equipment labeling. If equipment is not labeled, look at upstream device labels for an indication of the incident energy rating.
Flash Hazard Analysis Exception: In lieu of the flash hazard analysis, current edition of NFPA70E Table 130.7(C)(15)(A)(b) attached to this document, shall be used until all equipment is analyzed and posted, to determine the hazard/risk category and protective clothing for each task. The hazard/risk categories and required PPE are based on the assumed short-circuit current capacities and fault clearing times for the various tasks listed in the text and notes section in each table. For those tasks not listed, or for power systems greater than the assumed short-circuit current capacity or with longer than the assumed fault clearing times, a flash hazard analysis is required.

INSPECTION AND MAINTENANCE

Each department shall comply with the EH&S program for all portable electric tools, protective equipment, and electrical inspecting and testing equipment. The inspection and maintenance program shall include provisions for pre/post-use visual inspections and periodic documented inspections. The inspection program shall also include procedures for reporting and removing the tools and equipment from service.

Maintenance of Portable Electric Tools and Equipment

Workplaces shall ensure that employees operating portable electric tools conduct a visual inspection before and after use. Employees shall be instructed to recognized visible defects such as cut, frayed, spliced or broken cords; cracked or broken attachment plugs; and missing or deformed grounding prongs.

Protective equipment such as the following shall be maintained in a safe working condition, all equipment must be maintained in accordance with the manufacturer's recommendations or listing: and current ASTM standards

- Grounding Equipment
- Hot Sticks
- Rubber gloves, sleeves and leather protectors
- Voltage test indicators
- Blankets and similar insulating equipment
- Insulating mats and similar insulating equipment
- Protective barriers
- External circuit breaker rack out devices
- Portable lighting units
- Safety grounding equipment
- Dielectric footwear
- Protective clothing

Visual Inspection of Protective Equipment

All protective equipment shall be visually inspected for damage and defects before initial use and as service conditions require, but in no case shall the interval exceed 1 year.

The insulation of protective equipment and tools shall be verified by the appropriate test (i.e. ASTM standards or other standard) and visually inspected to ascertain that the insulating capability has been retained before initial use, and at intervals thereafter as service conditions and applicable testing standards and instructions require, but in no case shall the interval exceed three years.

Inspection and Testing of Grounding Equipment

INSTALLATION OF GROUNDING

For instruction on safety grounding / removal of safety ground connections **See Appendix "G"**. Personal protective ground cable sets shall be inspected for cuts in the protective sheath and damage to the conductors. Clamps and connector strain relief devices shall be checked for tightness. These inspections shall be conducted before initial use and as service conditions require, but in no case shall the interval exceed 1 year.

Prior to being returned to service, safety grounds that have been repaired or modified shall be tested to ascertain that 30-and 15-cycle maximum voltage drop values are not exceeded for the rating of the ground set. These tests shall be conducted as service conditions, applicable standards and instructions require, but in no case shall the interval exceed 3 years.

WORK ON OR NEAR OVERHEAD LINES

Where work is performed near overhead lines, the lines shall be de-energized and grounded or guarded before work begins.

De-energizing or guarding. If the lines are to be de-energized, arrangements shall be made with the organization that controls the lines to de-energize and visibly ground them at the point of work. If protective measures such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting the lines directly with any unguarded parts of their body or indirectly through conductive materials, tools, or equipment. Unqualified persons are prohibited from performing this type of work.

Each site manager, supervisor and the employee performing the work is responsible for ensuring that guards or protective measures are satisfactory for the conditions. Employees shall follow approved and established work methods and use protective equipment.

Approach Distances for Unqualified Persons. When an unqualified person is working on the ground or in an elevated position near overhead lines, the location shall be such that the employee and the longest conductive object the employee might contact come closer to any unguarded, energized overhead power line than the Limited Approach Boundary This distance for up to 50 kV is 10 ft.. For voltage that exceeds 50 kV, the distance shall be 10 ft. plus 4 in. for every 10 kV over 50 kV.

Vehicular and Mechanical Equipment.

Elevated Equipment:
Where any vehicle or mechanical equipment structure will be elevated near energized overhead lines, they shall be operated so that the Limited Approach Boundary distance is maintained per OSHA 29 CFR 1910.269. However, under any of the following circumstances, the clearances shall be permitted to be reduced:

If the vehicle is in transit with its structure lowered, the Limited Approach Boundary to overhead lines shall be reduced by 6 ft. If insulated barriers, rated for the voltages involved, are installed and they are not part of an attachment to the vehicle, the clearance shall be permitted to be reduced to the design working dimension of the insulating barrier.

b) If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and power line) shall be permitted to be reduced to the Restricted Approach boundary.

Equipment Contact:
Employees standing on the ground shall not contact the vehicle or mechanical equipment or any of its attachments, unless:
a) The employee is using protective equipment rated for the voltage, or
b) The equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in the Limited Approach Boundary.

Equipment Grounding:
If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding shall not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounded point.

7.0 End of Work

If the voltage of the electrical installation has been suppressed to carry out a job, it will only be reset when safe conditions are guaranteed for the workers who have carried it out and for all other people in the work place. The person responsible for this operation is the authorized /qualified worker responsible for the work.

The following steps must be taken to reset the voltage:

1. Removal of additional protections and of signals indicating the work limits, if any.

2. Removal of the ground connection and short-circuit, if any, see appendix for Instruction on Grounding / removal of ground connection.

3. De-blocking and/or removal of the signals of the shutoff devices according to procedure in Appendix “L “for de-energising, signalling and testing (LOTO).

4. Closure of circuits to reset the voltage.

8.0 Responsibilities

Hierarchic Head of the Location:

- Determine who is in charge of supervising the work.
- Information must be available of the person who directs the work in all cases, even though this decision may not depend on this person as it could be an external aspect.
- Have an updated list with all the employees authorised to carry out work and tasks with electric risk.
- Know all the actions and activities that are being carried out at the workplace that he or she is responsible for, and know the risks that the workers are exposed to.
- Establish the hazard control as a result of the assessment of the location for possible electric risks for personnel and establish people responsible for monitoring the control measures.

EH&S Supervisor/Coordinator:

- Define the training requirements for all those workers who are physically near the live installations or who work in locations with a fire or explosion risk (especially when there is a possibility of static electricity accumulating) and therefore may be exposed to electricity-generated risks.
- Have a properly documented inventory of electric risk situations.
- Have properly documented job instructions to carry out work safely and keep potential situations with electric risk under control.
- Provide guidance to General Management/Management about the technical and organizational adaptation necessary to satisfy all the regulatory and corporate safety requirements against electric risks.
- Coordinate the electric safety program.
- A job specific write up must be completed prior to the start of any work.
- A meeting coving the items included on the job specific write up must occur before the start of any work- **SEE APPENDIX "G"**

Work Manager:

- He or she assumes the effective responsibility for the work.
- Determine if the workers are suitable to carry out work in general and especially work with electric risks.

Line of Command:

- Analyse the need for work systematics and/or protection equipment against electric risk as an integral part of the planning prior to the work.
- Guarantee the supply and maintenance of the appropriate equipment for the work.
- Supervise the safety aspects before, during and after executing the work.
- Comply with all the safe work practices described by specific conditions and requirements of the location, work standards, information meetings prior to the work, training and other requirements of this document, that are under their control.

Qualified worker:

- Suppression and later resetting of voltage in High and Low Voltage installations.
- Carry out live work.
- Carry out proximity work on live elements.
- Preliminary safety checks for workers present at the location before starting the work.
- Watch over compliance with safety measures during the work.
- Guarantee that the safety conditions are maintained after work has finished.

Authorized worker:

- Suppression and later resetting of voltage in Low Voltage installations.
- Carry out proximity work on Low Voltage live elements
- Preliminary safety checks for workers present at the location before starting the work.
- Watch over compliance with safety measures during the work.
- Guarantee that the safety conditions are maintained after work has finished.

Worker: Inform the line of command of those electric risks that exist at the workplace and that have not been identified.

- Know how to use the equipment correctly and its functioning.
- Adequately use personal protective equipment.

9.0 Annexes (Appendix) and Attachments

Appendix "E" Energized Electrical Work Permit

Appendix "G" Instructions for Grounding / Removal of Grounding 1000 V or greater

Appendix "J" Electrical Job Briefing and Planning Checklist

Appendix "L" (LOTO) Lock out Tag out procedure's (29 cfr.1910.147)

Appendix "M" Meter Training and Certification

Appendix "P" University PPE Categories

Appendix "T" Tables from NFPA 70-ENFPA 70E Table 130.7(C)(15)(A),
Guidelines for working on equipment with unlisted hazards

10.0 Sources

1. 29 CFR 1910, Subpart I, "Personal Protective Equipment,"1910.137, "Electrical Protective Equipment."
2. 29 CFR 1910, Subpart S, "Electrical"
3. 29 CFR 1910.269, "Electric Power Generation, Transmission & Distribution".
4. 29 CFR 1910.331, "Scope".
5. 29 CFR 1910.332, "Training".
6. 29 CFR 1910.333, "Selection & Use of Safe Work Practices".
7. 29 CFR 1910.334, "Use of Equipment".
8. 29 CFR 1910.335, "Safeguards for Personal Protection".
9. NFPA 70 2014 Edition ":National Electrical Code"
10. NFPA 70-B 2013 Edition "Maintenance of Electrical Equipment"
11. NFPA 70E-2015, "Standards for Electrical Safety in the Workplace".
12. UL white Book 2014 Edition
13. ASTM Standards as applicable

11.0 Addendums

Addendum are as added or deleted from this document are listed on this page.

1. **Date: December 02, 2015 Revisions from the 2015 NFPA 70-E**

12.0 Job Descriptions

Job Description:

Hyperlink to the appropriate job

(EH&S to add the training requirements for each job description underneath the job classification)

http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/air_quality_tech_1_am.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/air_quality_tech_1_hvac.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/air_quality_tech_2_hvac.pdf

http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/emerg_bldg_maint_supt_1.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/bldg_maint_supt_1.pdf

http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/electrician_2.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/electrician_1.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/asst_electrician.pdf

http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/maint_repair_worker_1.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/maint_repair_worker_2.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/afscme/maint_repair_worker_3.pdf

http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/classified/bldg_maint_supt2_elec.pdf
http://www.uc.edu/content/dam/uc/hr/compensation/job_descriptions/classified/bldg_maint_supt3_elec.pdf

13.0 Appendixes

Appendix “E”

Appendix "E" Energized Electrical Work Permit

Part I: TO BE COMPLETED BY THE PERSON *REQUESTING* THE WORK BE COMPLETED IN AN ENERGIZED STATE:

OSHA 29 CFR 1919.333 (a) (1) requires that all electrical installation over 50 volts be placed in an electrically safe condition prior to working on, or near, any exposed electrical parts.

I understand that I am placing the person working on the electrical circuit in a potentially life threatening situation.

(1) Description of equipment and job location:

_____

_____

(2) Description of work to be done:

_____

_____

(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: (attach additional documentation if necessary)

_____

_____

_____ _____

Requester/Title (Print Name) Date

_____

Requester Signature

Part II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS *DOING* THE WORK:

Work order number:_____

(1)Criteria for energized work: (check one)

A. Creates a greater hazard _____

B. Life Safety _____

C. Continuous Industrial Process _____

(2) Verification of the electrical circuit to be worked on:

Panel Name: _____

Circuit Number: _____

OCPD Info Maintained per manufactures specs: Yes/No (If *no* return to requestor)

Breaker ☐

Fuse ☐

Rating _____

Clearing Time _____

(3) Description of the Safe Work Practices to be employed:

_____
_____
_____
_____
_____

(4) Shock Hazard Analysis: Voltage Level Phase to Phase _____

Approach Boundaries: Limited _____ Restricted _____

(5) Results of Flash Hazard Analysis:

Flash Protection Boundary: _____ (Assumed or Calculated)

Hazard/Risk Category _____ OR Calculated Flash Hazard at 18" _____

(6) Necessary personal protective equipment to safely perform the assigned task including the method used to determine the appropriate personal protective equipment: _____
_____

(7) Means employed to restrict the access of unqualified persons from the work area:

_____
_____

(8) Evidence of completion of a Job Briefing including discussion of any job-related hazards:

_____
_____

(9) Do you agree the above described work can be done safely? YES / NO (circle: If *no* return to requester)

_____ _____ _____ _____

Electrically Qualified Person(s) Date Electrically Qualified Person(s) Date

Part III: AUTHORIZED SIGNATURE OF APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:

Do you agree the above described work can be done safely? YES/NO (circle: If *no* return to requester)

_____ _____

NAME TITLE

Date_____

Part IV: DOCUMENATATION OF ELECTRICALLY ENERGIZED WORK:

I understand that the above Energized Work was completed on _____

Date

_____ Administrative Supervisor

NOTE: Once work is complete, forward a copy of this form to ES&H.

Appendix “G”

Appendix “G”

Sample Write up

Administration Sectionalizing Switch Replacement

Sunday, October 19th, 2014

Personnel

University of Cincinnati	
Utilities	2
West Campus Electric Shop	3
Hilvert and Pope	4
ECI	1
Total Personnel	10

Total project locks	7
Total project grounds	5

Personnel safety is of the utmost importance. If anyone sees something unsafe; please stop the work and alert University management and the situation will be reassessed.

Make sure that the buildings are pre-stocked with any supplies needed and that temporary lighting/ power is available prior to the shutdown.

Make sure that you have all power tool batteries charged and all tools necessary with you.

All personnel who enter the Nippert construction site are required to have safety glasses, hard hats and yellow safety vests.

Verification of switch positions and phase rotation shall be completed on October 17th, 2014 by Bob Luce and a campus electrician.

Check the fuel level on the generators that supply emergency power to the following buildings (fill if necessary prior to shut down):

Van Wormer	Teachers
University Pavilion	McMicken

Verification 10/13/2014

West Campus Knuckle

- Verify switch 1300 is closed
- Verify switch 800 is closed

Swift/SLC Sectionalizing Switch

- Verify switch 801 is closed
- Verify switch 802 is closed

Mary Emery Sectionalizing Switch

- Verify switch 804 is closed
- Verify switch 806 is closed

Dieterle Sectionalizing Switch

- Verify switch 808 is closed
- Verify switch 811 is closed

Siddall Sectionalizing Switch

- Verify switch 814 is closed
- Verify switch 816 is closed

Teachers College Sectionalizing Switch

- Verify switch 820 is closed
- Verify switch 1308 is closed

Administration Sectionalizing Switch

- Verify switch 1312 is closed
- Verify switch 1313 is closed
- Verify switch 1314 is closed
- Verify switch 1315 is closed
- Verify switch 1316 is closed
- Verify switch 1317 is closed

Old Chemistry Sectionalizing Switch

- Verify switch 1301 is closed
- Verify switch 1302 is closed
- Verify switch 1303 is closed
- Verify switch 1304 is open
    - Lock switch open
        - Lock # _____
    - Check voltages
        - Line side_____
        - Load side_____

Clifton Arch Sectionalizing Switch

- Verify switch 902 is closed
- Verify switch 1310 is open
- Lock switch open
    - Lock # _____
- Check Voltages
    - Line side_____
    - Load side_____

Phase Rotation Checks (Pre Shutdown)

Teachers College

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

McMicken

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

University Pavilion

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

Van Wormer

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

De-energizing Switching on 10/19/2014

- Call UCPD
- Call Emergency Maintenance
- Call Power plant

Administration Sectionalizing Switch

- Open switch 1313

Clifton Arch Sectionalizing Switch

- Test load side of switch 1310 for lack of voltage

Old Chemistry Sectionalizing Switch

- Test load side of switch 1304 for lack of voltage
    - Ground load side of switch
        - Number of grounds 1

Teachers College Sectionalizing Switch

- Open switch 1308
    - Lock switch open
        - Lock # _____

Teachers College

- Open switch 1320
  - Lock switch open
    - Lock # _____
  - Test for lack of voltage and ground line side of switch
    - Number of grounds 1
- Open main breaker

Administration Sectionalizing Switch

- Close switch 1313 to bleed off charge on cable 1313

McMicken Hall

- Open switch 1311
  - Lock switch open
    - Lock # _____
  - Test for lack of voltage and ground line side of switch
    - Number of grounds 1
- Open main breaker

University Pavilion

- Open switch 1318
  - Lock switch open
    - Lock # _____
  - Test for lack of voltage and ground line side of switch
    - Number of grounds 1
- Open main breaker

Van Wormer

- Open switch 1319
  - Lock switch open
    - Lock # _____
  - Test for lack of voltage and ground line side of switch
    - Number of grounds 1
- Open main breaker

Administration Sectionalizing Switch

- Open switch 1312
- Open switch 1313
- Open switch 1314
- Open switch 1315
- Open switch 1316
- Open switch 1317

Re-energizing Switching on 10/19/2014

We will be having a rally point at the Administration Sectionalizing Switch prior to energizing the system

Administration Sectionalizing Switch

- Verify switch 1312 is open
- Verify switch 1313 is open
- Verify switch 1314 is open
- Verify switch 1315 is open
- Verify switch 1316 is open
- Verify switch 1317 is open

Administration Sectionalizing Switch

- Close switch 1312
- Close switch 1313

Old Chemistry Sectionalizing Switch

- Remove grounds from switch 1304
  - Remove grounds
    - Number of grounds 1
- Remove lock
- Close switch

Teachers College Sectionalizing Switch

- Warning the line and load side blades of switch 1308 will be energized@ 12,470 volts
- Open switch 1308 enclosure
- Hot Phase between the line side and load side of the switch
- If hot phasing is correct skip to when hot phasing is ok section; if not correct go to next bullet point.
- Close the enclosure of switch 1308
- Open switch 1304 @ the Old Chemistry Sectionalizing switch and lock it open
    - Lock # _____
    - Test for lack of voltage on load side of switch
    - Ground load side of switch
        - Number of grounds 1
- Switch phases on Administration Sectionalizing Switch; switch # 1313.
- Go back to Old Chemistry Sectionalizing Switch and repeat sequence (in blue) for hot phasing.

When hot phasing is OKAY

Van Wormer

- Remove grounds from switch 1319
    - Number of grounds 1
- Unlock switch
- Close switch

University pavilion

- Remove grounds from switch 1318
    - Number of grounds 1
- Unlock switch
- Close switch

McMicken

- Remove grounds from switch 1311
    - Number of grounds 1
- Unlock switch
- Close switch

Teachers

- Remove grounds from switch1320
    - Number of grounds 1
- Unlock switch
- Close switch

Administration Sectionalizing Switch

- Close switch 1314
- Close switch 1315
- Close switch 1316
- Close switch 1317

Check individual building phase rotation

If phase rotation is incorrect

Old Chemistry Sectionalizing Switch

- Open switch 1304
- Test for lack of voltage on load side of switch
- Install grounds on load side of switch
    - Number of grounds 1
- Lock switch open
    - Lock # _____

Administration Sectionalizing Switch

- Open switch that corresponds to the building with the incorrect rotation
- Swap two phases
- Close switch that corresponded to the building with the incorrect phase rotation

Old Chemistry Sectionalizing Switch

- Remove ground from switch 1304
- Remove lock from switch
- Close switch

Retest Phase rotation on building

If correct phase rotation on all buildings

Old Chemistry Sectionalizing Switch

- Open switch 1304

Van Wormer

- Close main breaker at Van Wormer

University Pavilion

- Close main breaker at University Pavilion

McMicken

- Close main breaker at McMicken

Teachers

- Close main breaker at Teachers

Old Chemistry Sectionalizing Switch

- Close switch 1304
  Place system back onto 1300 loop and de-energize the 12,470V cable that runs through the Nippert Construction Site; this cable runs between Swift/SLC Sectionalizing Switch; switch #802 and the Mary Emery Sectionalizing Switch; switch #804

Teachers College Sectionalizing Switch

- Remove lock and close switch 1308

Mary Emery Sectionalizing Switch

- Open switch 804
- Lock switch open
  - Lock #_____

Swift/SLC Sectionalizing Switch

- Open switch 802
- Lock switch open
  - Lock # _____

Phase Rotation Checks (Post Shutdown)

Teachers College

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

McMicken

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

University Pavilion

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

Van Wormer

- A phase _____
- B phase _____
- C phase _____
- Rotation CW or CCW

Appendix “J”

Appendix "J" Electrical Briefing and Planning Checklist

Project Location:_____

PART I Identification (add sheets if necessary)

Hazards: _____
_____
_____

Confined Space: Y N

Unusual Conditions: _____
_____
_____

Secondary Energy Sources:
Electric _____ Mechanical _____
Steam _____ Other _____

Part II NFPA 70E (add sheets if necessary)

Arc Flash Potential	Y N	Voltage	_____
De-energization Possible	Y N	Shock Boundary	_____
Energized Work Permit Required	Y N	Flash Boundary	_____
Voltage Verification	Y N	Incident Energy	_____ cal/cm^2
LOTO Required	Y N		
PPE Required	Y N	UC PPE Category	2 4
Grounds Required	Y N		
Possible Back feed	Y N		

Describe: _____
_____
_____

Continued on back

Part III Planning (add sheets if necessary)

Job Description: _____
_____
_____
_____

Person in charge _____

Electrical Safety Program Consulted Y N
Are current blueprints or
Single line drawings
Available Y N
Are emergency response
Equipment and
Personnel available Y N
Method of Contact _____
Emergency Action Plan Developed Y N
Shutdown Notification Distributed Y N
To whom: _____
_____
_____

Part IIII Signatures

Completed by: _____ Date: _____
Printed

_____
Sign

Return original form to EH&S
Mail location 0218

Appendix “L”

Refer to University of Cincinnati LOTO program on EH&S website

Appendix “M”

Appendix "M" Meter Training and Certification

Part I Identification

Employee: _____
Job Classification: _____
Department: _____

Part II Type of Meter Trained On

Fluke T-5 1000	Y N	Fluke 374	Y N
Fluke 179	Y N	Fluke 87 V	Y N
Fluke AC-1	Y N		
Chance Medium Voltage Hot Phase Meter	Y N	Other (describe) _____	

Part III Understanding and Performance

Understands meanings of all selection knob positions	Y N	Chose correct meter for application	Y N
Chose correct PPE for measurement task	Y N	Performed visual inspection of meter prior to use	Y N
Performed 3 step testing prior to testing target	Y N	Made correct indication of measurement quantity	Y N

Part IV Certification (Attach sheets if necessary)

Pass Fail Explain failure: _____
_____
Employee Signature: _____
Trainer Signature: _____
Date: _____

Appendix “P”

University of Cincinnati Level 2 PPE
All clothing shall be rated @ 8 cal/cm^2 minimum.

Arc rated hard hat and face shield
Balaclava
Arc rated ear plugs
Safety glasses ANSI rating of Z87.1
Arc rated long-sleeve shirt and pants.
Rubber gloves rated Class 0 or higher (Within testing date)
    Black rubber gloves from January 1 thru June 30
    Red rubber gloves from July 1 thru December 31
Leather protectors for rubber gloves.
Leather safety toed footwear.

University of Cincinnati Level 4 PPE
All University Level 2 PPE plus:

Arc rated flash suit hood rated @ 40 cal/cm^2.
Arc rated flash suit jacket rated @ 40 cal/cm^2.
Arc rated flash suit pants rated @ 40 cal/cm^2.
Rubber gloves rated Class 2 or higher (Within testing date)

Appendix “T”

Tables Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating **Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems**

Task	**Equipment Condition***	**Arc Flash PPE Required**
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor, or starter	All of the following: • The equipment is properly installed • The equipment is properly maintained • All equipment doors are closed and secured • All equipment covers are in place and secured • There is no evidence of impending failure	No
	One or more of the following: • The equipment is not properly installed • The equipment is not properly maintained • Equipment doors are open or not secured • Equipment covers are off or not secured • There is evidence of impending failure	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes
For dc systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing	Any	Yes
Voltage testing on individual battery cells or individual multi-cell units	All of the following: • The equipment is properly installed • The equipment is properly maintained • Covers for all other equipment are in place and secured • There is no evidence of impending failure	No
	One or more of the following:	Yes

	• The equipment is not properly installed • The equipment is not properly maintained • Equipment doors are open or not secured • Equipment covers are off or not secured • There is evidence of impending failure	
Removal or installation of CBs or switches	Any	Yes
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare energized electrical conductors and circuit parts	All of the following: • The equipment is properly installed • The equipment is properly maintained • There is no evidence of impending failure	NO
	Any of the following: • The equipment is not properly installed • The equipment is not properly maintained • There is evidence of impending failure	Yes
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.	Any	Yes
Removal of battery intercell connector covers	All of the following: • The equipment is properly installed. • The equipment is properly maintained • Covers for all other equipment are in place and secured • There is no evidence of impending failure	No
	One or more of the following: • The equipment is not properly installed • The equipment is not properly maintained • Equipment doors are open or not secured • Equipment covers are off or not secured • There is evidence of impending failure	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)	Any	Yes
Perform infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.	Any	No
Application of temporary protective grounding equipment after voltage test	Any	Yes
Work on control circuits with exposed energized electrical conductors and circuit parts, 120 volts or below without any other exposed energized equipment over 120 V including opening of hinged covers to gain access	Any	No
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes
Insertion or removal of individual starter buckets from motor control center (MCC)	Any	Yes
Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed	Any	Yes
Insertion or removal of plug-in devices into or from busways	Any	Yes
Insulated cable examination with no manipulation of cable	Any	No
Insulated cable examination with manipulation of cable	Any	Yes
Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center	Any	Yes
Insertion and removal of revenue meters (kW-hour, at primary voltage and current)	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an enclosure	Any	Yes

For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack	Any	No
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack	Any	No
For dc systems, work on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source	Any	Yes
Arc-resistant switchgear Type 1 or 2 (for clearing times of ☐ with a prospective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switchgear, fused or unfused of arc resistant type construction, tested in accordance with IEEE C37.20.7: • Insertion or removal (racking) of CBs from cubicles • Insertion or removal (racking) of ground and test device • Insertion or removal (racking) of voltage transformers on or off the bus	All of the following: • The equipment is properly installed • The equipment is properly maintained • All equipment doors are closed and secured • All equipment covers are in place and secured • There is no evidence of impending failure	No
	One or more of the following: • The equipment is not properly installed • The equipment is not properly maintained • Equipment doors are open or not secured • Equipment covers are off or not secured • There is evidence of impending failure	Yes
Opening voltage transformer or control power transformer compartments	Any	Yes
Outdoor disconnect switch operation (hookstick operated) at 1kV through 15 kV	Any	Yes
Outdoor disconnect switch operation (gang-operated, from grade) at 1 kV through 15 kV	Any	Yes

Note: Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this table does not cover every possible condition or situation. Where this table indicates that arc flash PPE is not required, an arc flash is not likely to occur.

*The phrase *properly installed*, as used in this table, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained*, as used in this table, means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure*, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.

Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	**1**	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	**2**	
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	**2**	1.5 m (5 ft.)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	**4**	4.3 m (14 ft.)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	**4**	6 m (20 ft.)

Other 600-V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short-circuit current available; maximum of up to 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	**2**	1.5 m (5. Ft.)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	**4**	12 m (40 ft.)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	**4**	12 m (40 ft.)
Arc-resistant switchgear Type 1 or 2 [for clearing times of < 0.5 sec (30 cycles) with a perspective fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	N/A (doors closed)	N/A (doors closed)
	4 (doors open)	12 m (40 ft.)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	**4**	12 m (40 ft.)

Note: For equipment rated 600 volts and below, and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

Table 130.7(C)(15)(B) Arc-Flash Hazard PPE Categories for Direct Current (dc) Systems

Equipment	**Arc Flash PPE Category**	**Arc-Flash Boundary**
Storage batteries, dc switchboards, and other dc supply sources 100 V > Voltage < 250 V Parameters:		

Voltage: 250 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current < 4 kA	**1**	900 mm (3 ft.)
4 kA δ short-circuit current < 7 kA	**2**	1.2 m (4 ft.)
7 kA δ short-circuit current < 15 kA	**3**	1.8 m (6 ft.)
Storage batteries, dc switchboards, and other dc supply sources 250 V δ Voltage δ 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current 1.5 kA	**1**	900 mm (3 ft.)
1.5 kA ≤ short-circuit current < 3 kA	**2**	1.2 m (4 ft.)
3 kA δ short-circuit current < 7 kA	**3**	1.8 m (6 ft.)
7 kA δ short-circuit current < 10 kA	**4**	2.5 m (8 ft.)

Note: Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:
(1) Be evaluated for electrolyte protection in accordance with ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*
(2) Be arc-rated in accordance with ASTM F1891, *Standard Specification for Arc Rated and Flame Resistant Rainwear*, or equivalent